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ANNUAL STATUS REPORT

for

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"Data Validation for Total Ozone Mapping Spectrometer
for Small Class Observer"

J. L. Stanford, Principal Investigator

The goal of this project is to provide detailed analyses of previous TOMS gridded data with which the data from the next TOMS instrument can be checked and validated. Time/spectral comparisons will be used to provide sensitive tests on instrument operation and details of data calibration, retrieval, and gridding alogorithms.

Progress during the past 12 months:

1. We have completed space-time analyses of the new Version 7 TOMS data and compared with Version 6 TOMS. The results are now being prepared as a NASA Reference Publication. Tentative authorship and title of the document is:

M. A. Olsen and J. L. Stanford (Department of Physics and Astronomy, Iowa State University) and R. D. McPeters and J. R. Ziemke (NASA Goddard Space Flight Center, Greenbelt, Maryland), 1997:

"Space-time Spectral Analysis Comparison of Version 6 and 7 Nimbus 7 TOMS Ozone Fields"

Abstract: Total column ozone fields from TOMS Version 7 Data are analyzed by space-time spectral analysis and compared with previous analyses of Version 6 data. One purpose of this note is to briefly comment on some differences between these two data sets. A second purpose is to help prospective TOMS users avoid several pitfalls inherent in analyzing TOMS data. Among the differences noted are improvements in the treatments of the known wave 1 low latitude feature and of large solar zenith angle effects at high latitudes. A variety of low amplitude, traveling features are noted, some of which are atmospheric in origin and some of which may be related to the orbital characteristics or retrieval methods. Interpretations of these in terms of atmospheric dynamics should thus be made with care. Overall, the sensitive tests provided by space-time decomposition suggest that TOMS Version 7 constitute an improved global data set valuable for investigations of total ozone.

2. We have been analyzing total ozone measurements from the SBUV instrument, employing space-time spectral analyses similar to those in the above paper with TOMS data. A draft of a paper is being prepared for submission for publication:

J. R. Ziemke (Software Corporation of America, Lanham, MD), J. R. Herman(NASA Goddard Space Flight Center, Greenbelt, MD), J. L. Stanford(Department of Physics and Astronomy, Iowa State University, Ames, IA) and P. K. Bhartia(NASA Goddard Space Flight Center, Greenbelt, MD)

"Satellite ozone observation horizontal resolution requirement for next-day total ozone and UVB prediction."

Abstract: Concern over ozone loss and potential increase in surface level ultraviolet-B (wavelengths 280-320 nm) has led to development and refinement of schemes for short term prediction of total column ozone (Omega). These are often initialized with ozone fields from current SBUV2 (Solar Backscattered Ultraviolet 2) measurements on operational meteorological satellites. In this paper we compare the zonal resolution of SBUV2 Omega fields with those from the new NASA Earth Probe (EP) and Advanced Earth Observing Satellite (ADEOS) Total Ozone Mapping Spectrometer (TOMS) scanning spectrometers. The latter side scanning instruments are sufficient to resolve the medium scale waves that dominate day to day midlatitude Omega fluctuations, whereas the nadir-only SBUV2 instrument does not. This result has consequences for short time scale ozone and UVB predictions because time scales of a few days are coupled to medium horizontal scales (several thousand km) by baroclinic waves which typically force the observed Omega variations. We use a simple Omega prediction model to test the use of Omega fields from all three instruments and show that use of higher zonal resolution for the Omega initialization fields results in much lower Omega prediction errors.

3. We have also been investigating simple methods for estimating, several days in advance, total column ozone over a given location. The technique is based on the long known association between total ozone and weather systems. Initial results show that use of next day predictions of lower stratospheric temperature from a forecast model can be used to estimate summertime total column ozone to accuracy comparable with or exceeding that of more sophisticated weather service models. The results have importance for forecasting of ultraviolet radiation (UV Index) for various cities.

Two papers have resulted from this work:

3a. J. L. Stanford (Iowa State University) and J. R. Ziemke (Goddard Space Flight Center):

"A practical method for predicting midlatitude total column ozone from operational forecast temperature fields"

J. Geophys. Res., 101, 28,769-28,773 (1996)

Abstract: Accurate forecasts of total column ozone (Omega) are important because, among other reasons, forecasts of clear-air biologically-important solar ultraviolet (UVB) reaching the earth's surface are exponentially sensitive to Omega. We present a simple method for predicting Omega using forecast lower stratospheric temperatures and a precalculated look-up table based on ozone climatology from several years of satellite observations. Compared with observations, the simple method gives one-day forecast Omega errors of 1-2% (2-3%) in Northern (Southern) Hemisphere summers, comparable with current multivariate UVB forecast models being used by national weather services in several countries. The advantage of the prediction method described here is its simplicity: a convenient look-up table based upon ozone climatology is used, without the need for recalculation in each forecast. The method may prove useful for surface UVB forecasts, especially in the biologically important summer seasons of both hemispheres.

3b. J. R. Ziemke (Goddard Space Flight Center) and J. L. Stanford (Iowa State University)

"Correlation of Total Ozone with Dynamical Variables"

To appear in Quad. Ozone Symposium Proc. (WMO, 1997)

Abstract: Recently Stanford and Ziemke developed a model for predicting total column ozone (Omega) from lower stratospheric temperatures and a pre-calculated look-up table based on several years of satellite ozone observations. The present paper extends that work by examining correlations between Omega and a number of other dynamical variables. Omega prediction models based on multiple dynamical variables are not found to reduce prediction errors over the single-variable model. This is attributed to observational and computational noise. Further results from the temperature-dependent Omega prediction model reveal that it captures medium scale Omega features well in summer midlatitudes of both hemispheres and that, depending on the accuracy of predicted temperatures from operational forecasts, Omega predictions may be made a number of days in advance. Because solar ultraviolet reaching the earth's surface is exponentially dependent on Omega, these results may be useful for UV predictions a number of days in advance in the biologically important summer seasons.

4. We are also investigating the extent to which analyses of SBUV data can be used to discern whether the well-known wave one feature found in TOMS data is tropospheric or stratospheric in origin. A manuscript is being prepared for journal submission:

M. S. Lewis and J. L. Stanford (both Dept. of Physics and Astronomy, Iowa State University, Ames, IA, R. D. McPeters and P. K. Bhartia, (both NASA Goddard Space Flight Center, Greenbelt, MD), L. E. Flynn (NOAA/ESEDIS/ORA, Washington DC), and J. R. Ziemke (Software Corporation of America, Lanham, MD)

"On The Altitude Of The Low-latitude Wave One Anomaly In Total Column Ozone"

Abstract: Tropospheric ozone plays an important role in the atmospheric chemistry chain but its global distribution is poorly known due to uncertainties in measurement from

space. An example is current discussion of whether the well-known low-latitude global scale anomaly in total ozone lies primarily in the troposphere or stratosphere. Recently, Ziemke et al. [1996] presented satellite and ozonesonde evidence for a mid tropospheric location of the ozone anomaly. A critical element in their argument was comparison of ozonesonde station data from key locations but covering different years, thus requiring the assumption of statistical stationarity. The present paper circumvents the stationarity assumption by analyzing contemporaneous ozone vertical profiles retrieved from space-borne solar backscatter ultraviolet (SBUV) measurements. SBUV cannot directly resolve ozone profile details in the lowest stratosphere and below. However, when spectral analysis of retrieved ozone profiles is coupled with careful examination of SBUV retrieval details, the results are found to be consistent with a tropospheric origin for the low-latitude ozone anomaly, corroborating the Ziemke et al. results.

5. We are beginning to investigate small scale structure in EP TOMS data. The idea is to utilize the enhanced resolution of EP TOMS to study dynamical structure near baroclinic storm regions. This research is in an early stage, but initial results are encouraging. EP TOMS data appear to be of high quality.

Future: Continued preparation for publication of the articles described in Items 1,2 and 4 will be continued. The new research under Item 5 will be a major focus for development in the next 12 months.

Copies of this report are being sent to Dr. R. D. McPeters, Project Scientist, and Dr. A. J. Krueger, Technical Officer, Code 916, Goddard Space Flight Center, Greenbelt, MD 20771, and two to the NASA Scientific and Technical Information Facility, 800 Elkridge Landing Road, Linthicum Heights, MD 21090.

John L. Stanford
John L. Stanford
Principal Investigator
Professor of Physics
Iowa State University

cc:

Dr. R. S. Stolarski
Code 916
Goddard Space Flight Center
Greenbelt, MD 20771

Dr. P. K. Bhartia
Code 916
Goddard Space Flight Center
Greenbelt, MD 20771

Dr. Jack Kaye, Manager
Atmospheric Chemistry Program,
Modeling and Analysis
Mail Code SED 05
NASA Headquarters
Washington, DC 20546

Ms. Gloria Blanchard
Code 286.1
NASA Goddard Space Flight Center
Greenbelt, MD 20771

Mr. Richard Hasbrook
Mrs. Val Kettner
Contracts and Grants
213 Beardshear Hall
Iowa State University

Ms. Eva Kinstle
Physics and Astronomy
Iowa State University